

DATA SHEET

BFG403W

NPN 17 GHz wideband transistor

Product specification
Supersedes data of 1997 Oct 29
File under Discrete Semiconductors, SC14

1998 Mar 11

NPN 17 GHz wideband transistor

BFG403W

FEATURES

- Low current
- Very high power gain
- Low noise figure
- High transition frequency
- Very low feedback capacitance.

APPLICATIONS

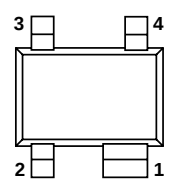
- Pager front ends
- RF front end
- Wideband applications, e.g. analog and digital cellular telephones, cordless telephones (PHS, DECT, etc.)
- Radar detectors.

DESCRIPTION

NPN double polysilicon wideband transistor with buried layer for low voltage applications in a plastic, 4-pin dual-emitter SOT343R package.

PINNING

PIN	DESCRIPTION
1	emitter
2	base
3	emitter
4	collector



Top view MSB842

Marking code: P3.

Fig.1 Simplified outline SOT343R.

QUICK REFERENCE DATA

SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
V _{CBO}	collector-base voltage	open emitter	–	–	10	V
V _{CEO}	collector-emitter voltage	open base	–	–	4.5	V
I _C	collector current (DC)		–	3	3.6	mA
P _{tot}	total power dissipation	T _S ≤ 140 °C	–	–	16	mW
h _{FE}	DC current gain	I _C = 3 mA; V _{CE} = 2 V; T _j = 25 °C	50	80	120	
C _{re}	feedback capacitance	I _C = 0; V _{CB} = 2 V; f = 1 MHz	–	20	–	fF
f _T	transition frequency	I _C = 3 mA; V _{CE} = 2 V; f = 2 GHz; T _{amb} = 25 °C	–	17	–	GHz
G _{max}	maximum power gain	I _C = 3 mA; V _{CE} = 2 V; f = 2 GHz; T _{amb} = 25 °C	–	22	–	dB
F	noise figure	I _C = 1 mA; V _{CE} = 2 V; f = 900 MHz; Γ _S = Γ _{opt}	–	1	–	dB

CAUTION

This product is supplied in anti-static packing to prevent damage caused by electrostatic discharge during transport and handling. For further information, refer to Philips specs.: SNW-EQ-608, SNW-FQ-302A and SNW-FQ-302B.

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LIMITING VALUES

In accordance with the Absolute Maximum Rating System (IEC 134).

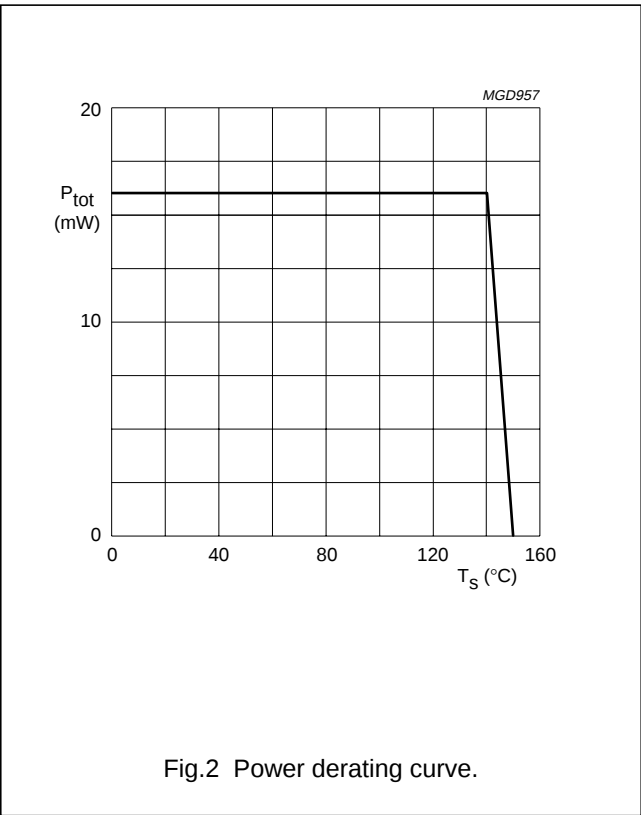
SYMBOL	PARAMETER	CONDITIONS	MIN.	MAX.	UNIT
V _{CBO}	collector-base voltage	open emitter	–	10	V
V _{CEO}	collector-emitter voltage	open base	–	4.5	V
V _{EBO}	emitter-base voltage	open collector	–	1	V
I _C	collector current (DC)		–	3.6	mA
P _{tot}	total power dissipation	T _s ≤ 140 °C; note 1; see Fig.2	–	16	mW
T _{stg}	storage temperature		–65	+150	°C
T _j	operating junction temperature		–	150	°C

Note

1. T_s is the temperature at the soldering point of the emitter pins.

THERMAL CHARACTERISTICS

SYMBOL	PARAMETER	VALUE	UNIT
R _{th j-s}	thermal resistance from junction to soldering point	820	K/W



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CHARACTERISTICS

$T_j = 25\text{ }^{\circ}\text{C}$ unless otherwise specified.

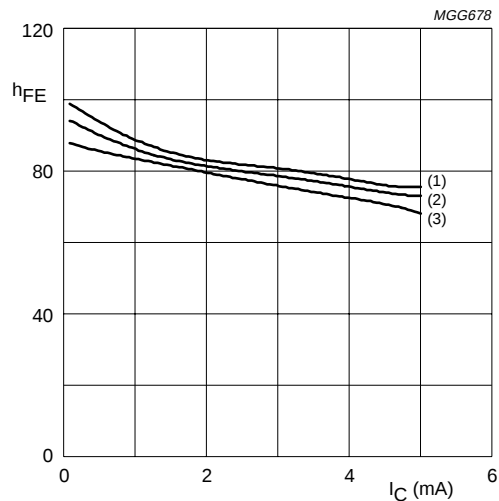
SYMBOL	PARAMETER	CONDITIONS	MIN.	TYP.	MAX.	UNIT
$V_{(BR)CBO}$	collector-base breakdown voltage	$I_C = 2.5\text{ }\mu\text{A}$; $I_E = 0$	10	–	–	V
$V_{(BR)CEO}$	collector-emitter breakdown voltage	$I_C = 1\text{ mA}$; $I_B = 0$	4.5	–	–	V
$V_{(BR)EBO}$	emitter-base breakdown voltage	$I_E = 2.5\text{ }\mu\text{A}$; $I_C = 0$	1	–	–	V
I_{CBO}	collector-base leakage current	$I_E = 0$; $V_{CB} = 4.5\text{ V}$	–	–	15	nA
h_{FE}	DC current gain	$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; see Fig.3	50	80	120	
C_c	collector capacitance	$I_E = i_e = 0$; $V_{CB} = 2\text{ V}$; $f = 1\text{ MHz}$	–	170	–	fF
C_e	emitter capacitance	$I_C = i_c = 0$; $V_{EB} = 0.5\text{ V}$; $f = 1\text{ MHz}$	–	315	–	fF
C_{re}	feedback capacitance	$I_C = 0$; $V_{CB} = 2\text{ V}$; $f = 1\text{ MHz}$; see Fig.4	–	20	–	fF
f_T	transition frequency	$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; see Fig.5	–	17	–	GHz
G_{max}	maximum power gain; note 1	$I_C = 0.5\text{ mA}$; $V_{CE} = 1\text{ V}$; $f = 900\text{ MHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; see Figs 6 and 8	–	20	–	dB
		$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; see Figs 7 and 8	–	22	–	dB
$ S_{21} ^2$	insertion power gain	$I_C = 0.5\text{ mA}$; $V_{CE} = 1\text{ V}$; $f = 900\text{ MHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; see Fig.8	–	5	–	dB
		$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$; $T_{amb} = 25\text{ }^{\circ}\text{C}$; see Fig.8	–	14	–	dB
F	noise figure	$I_C = 1\text{ mA}$; $V_{CE} = 2\text{ V}$; $f = 900\text{ MHz}$; $\Gamma_S = \Gamma_{opt}$; see Fig.13	–	1	–	dB
		$I_C = 1\text{ mA}$; $V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$; $\Gamma_S = \Gamma_{opt}$; see Fig.13	–	1.6	–	dB
P_{L1}	output power at 1 dB gain compression	$I_C = 1\text{ mA}$; $V_{CE} = 1\text{ V}$; $f = 900\text{ MHz}$; $Z_S = Z_{S\text{ opt}}$; $Z_L = Z_{L\text{ opt}}$; note 2	–	–5	–	dBm
ITO	third order intercept point	$I_C = 1\text{ mA}$; $V_{CE} = 1\text{ V}$; $f = 900\text{ MHz}$; $Z_S = Z_{S\text{ opt}}$; $Z_L = Z_{L\text{ opt}}$; note 2	–	6	–	dBm

Notes

- G_{max} is the maximum power gain, if $K > 1$. If $K < 1$ then $G_{max} = MSG$; see Figs 6, 7 and 8.
- Z_S is optimized for noise; Z_L is optimized for gain.

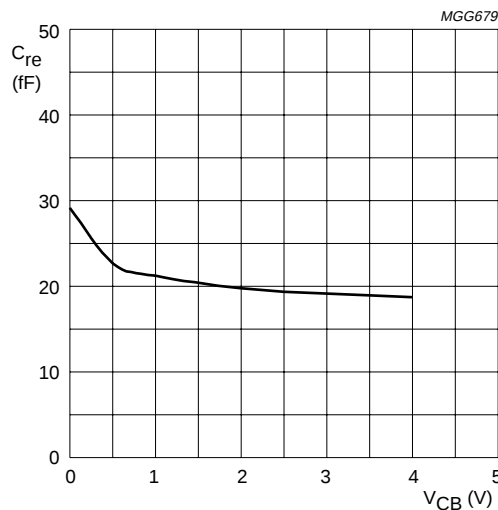
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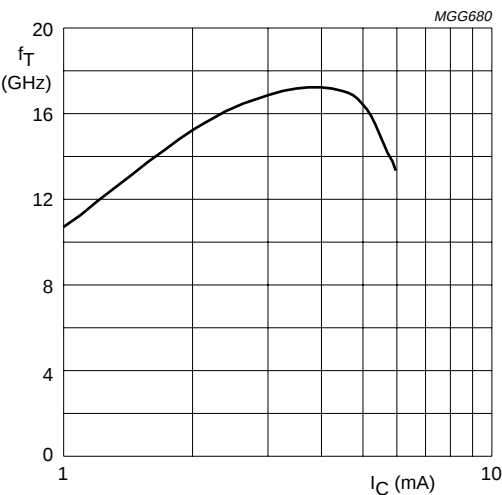
- (1) $V_{CE} = 3$ V.
- (2) $V_{CE} = 2$ V.
- (3) $V_{CE} = 1$ V.

Fig.3 DC current gain as a function of collector current; typical values.



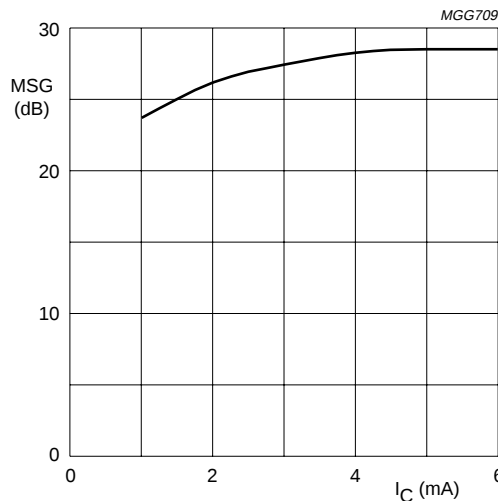
$I_C = 0$; $f = 1$ MHz.

Fig.4 Feedback capacitance as a function of collector-base voltage; typical values.



$V_{CE} = 2$ V; $f = 2$ GHz; $T_{amb} = 25$ °C.

Fig.5 Transition frequency as a function of collector current; typical values.

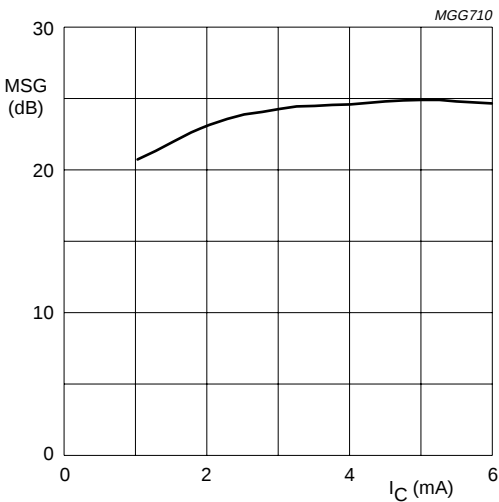


$V_{CE} = 2$ V; $f = 900$ MHz.

Fig.6 Maximum stable gain as a function of collector current; typical values.

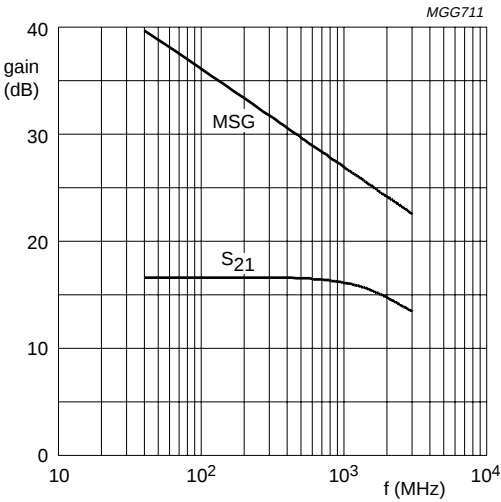
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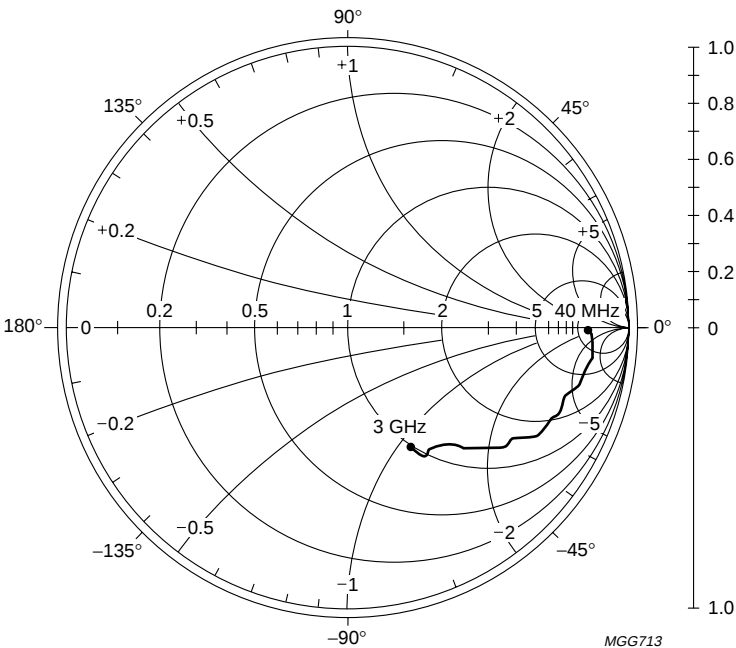
$V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$.

Fig.7 Maximum stable gain as a function of collector current; typical values.



$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$.

Fig.8 Gain as a function of frequency; typical values.

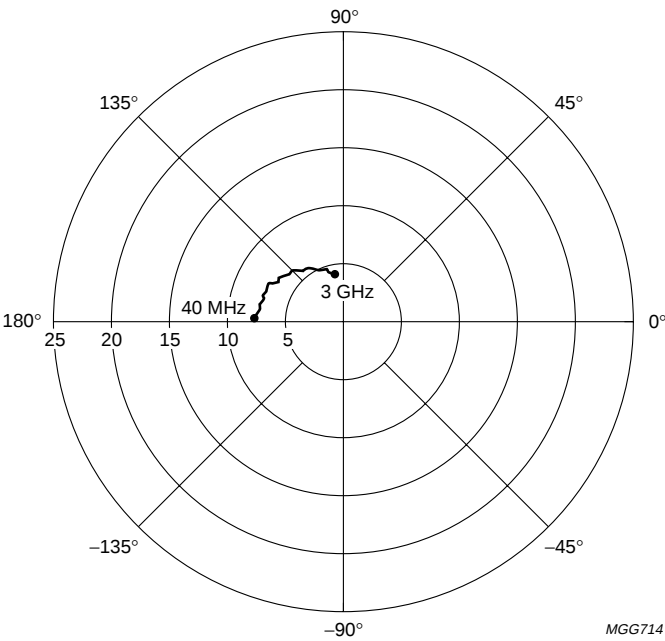


$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; $Z_0 = 50\text{ }\Omega$.

Fig.9 Common emitter input reflection coefficient (S_{11}); typical values.

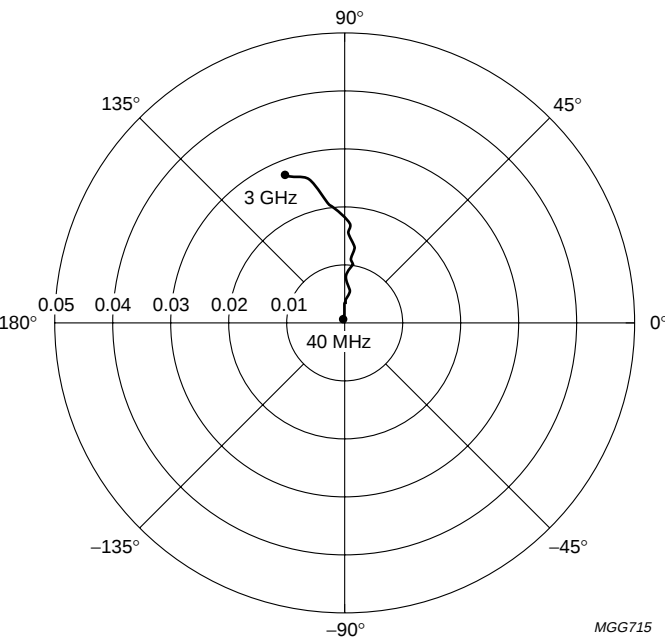
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$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$.

Fig.10 Common emitter forward transmission coefficient (S_{21}); typical values.

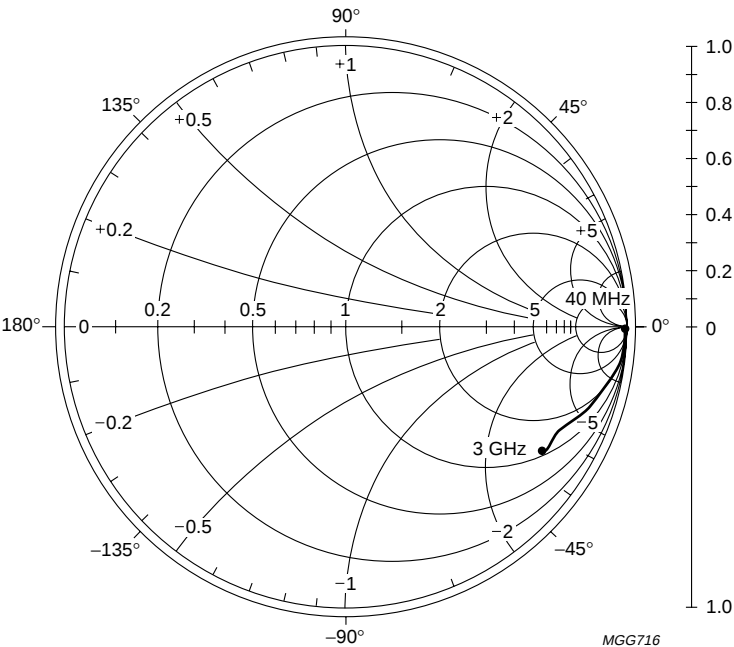


$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$.

Fig.11 Common emitter reverse transmission coefficient (S_{12}); typical values.

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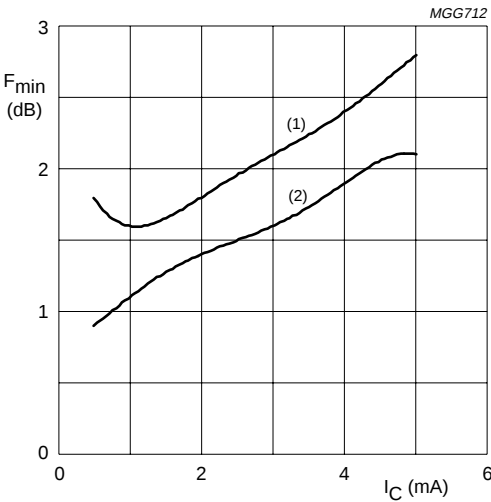
$I_C = 3\text{ mA}$; $V_{CE} = 2\text{ V}$; $Z_0 = 50\ \Omega$.

Fig.12 Common emitter output reflection coefficient (S_{22}); typical values.

Noise data

$V_{CE} = 2\text{ V}$; typical values.

f (MHz)	I_C (mA)	F_{min} (dB)	Γ_{mag}	Γ_{angle}	r_n (Ω)
900	0.5	0.9	0.91	4.7	1.41
	1	1.1	0.83	5.1	1.12
	2	1.4	0.71	5.1	0.97
	3	1.6	0.62	5.0	0.88
	4	1.9	0.56	4.9	0.84
	5	2.1	0.50	4.2	0.82
2000	0.5	1.8	0.71	27.5	1.47
	1	1.6	0.74	26.1	1.11
	2	1.8	0.64	26.3	0.93
	3	2.1	0.56	26.1	0.91
	4	2.4	0.48	26.7	0.9
	5	2.8	0.45	25.8	0.85



(1) $V_{CE} = 2\text{ V}$; $f = 2\text{ GHz}$.
(2) $V_{CE} = 2\text{ V}$; $f = 900\text{ MHz}$.

Fig.13 Minimum noise figure as a function of the collector current; typical values.

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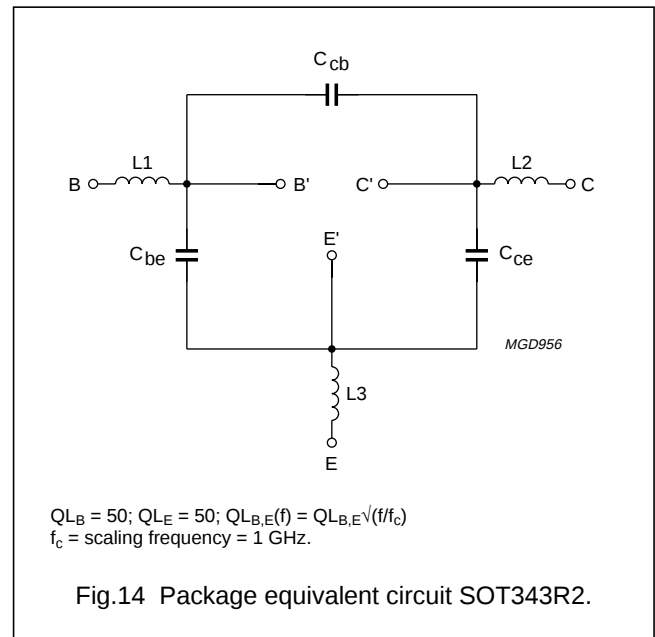
SPICE parameters for the BFG403W die

SEQUENCE No.	PARAMETER	VALUE	UNIT
1	IS	5.554	aA
2	BF	145.0	–
3	NF	0.993	–
4	VAF	31.12	V
5	IKF	35.75	mA
6	ISE	35.35	fA
7	NE	3.000	–
8	BR	11.37	–
9	NR	0.985	–
10	VAR	1.874	V
11	IKR	0.014	A
12	ISC	57.08	aA
13	NC	1.546	–
14	RB	122.4	Ω
15	IRB	0.000	A
16	RBM	52.45	Ω
17	RE	1.511	Ω
18	RC	15.12	Ω
19 ⁽¹⁾	XTB	1.500	–
20 ⁽¹⁾	EG	1.110	eV
21 ⁽¹⁾	XTI	3.000	–
22	CJE	36.61	fF
23	VJE	900.0	mV
24	MJE	0.346	–
25	TF	4.122	ps
26	XTF	68.20	–
27	VTF	2.004	V
28	ITF	0.179	A
29	PTF	0.000	deg
30	CJC	16.21	fF
31	VJC	556.9	mV
32	MJC	0.207	–
33	XCJC	0.500	–
34 ⁽¹⁾	TR	00.00	ns
35 ⁽¹⁾	CJS	78.59	fF
36 ⁽¹⁾	VJS	418.3	mV
37 ⁽¹⁾	MJS	0.239	–
38	FC	0.550	–

SEQUENCE No.	PARAMETER	VALUE	UNIT
39 ⁽²⁾⁽³⁾	C_{bp}	145	fF
40 ⁽²⁾	R_{sb1}	25	Ω
41 ⁽³⁾	R_{sb2}	19	Ω

Notes

1. These parameters have not been extracted, the default values are shown.
2. Bonding pad capacity C_{bp} in series with substrate resistance R_{sb1} between B' and E'.
3. Bonding pad capacity C_{bp} in series with substrate resistance R_{sb2} between C' and E'.



List of components (see Fig.14)

DESIGNATION	VALUE	UNIT
C_{be}	80	fF
C_{cb}	2	fF
C_{ce}	80	fF
L1	1.1	nH
L2	1.1	nH
L3 (note 1)	0.25	nH

Note

1. External emitter inductance to be added separately due to the influence of the printed-circuit board.

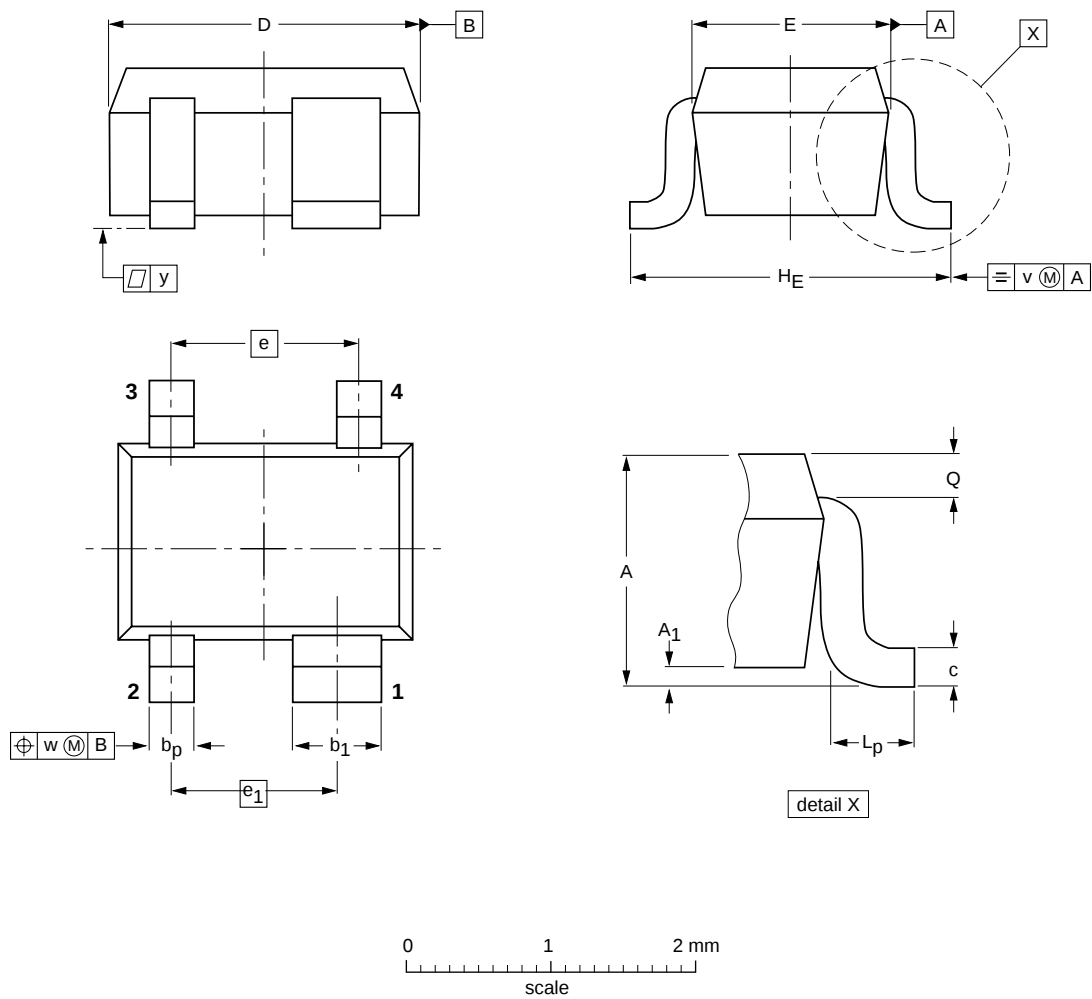
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PACKAGE OUTLINE

Plastic surface mounted package; reverse pinning; 4 leads

SOT343R



DIMENSIONS (mm are the original dimensions)

UNIT	A	A ₁ max	b _p	b ₁	c	D	E	e	e ₁	H _E	L _p	Q	v	w	y
mm	1.1 0.8	0.1	0.4 0.3	0.7 0.5	0.25 0.10	2.2 1.8	1.35 1.15	1.3	1.15	2.2 2.0	0.45 0.15	0.23 0.13	0.2	0.2	0.1

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT343R						97-05-21

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DEFINITIONS

Data Sheet Status	
Objective specification	This data sheet contains target or goal specifications for product development.
Preliminary specification	This data sheet contains preliminary data; supplementary data may be published later.
Product specification	This data sheet contains final product specifications.
Limiting values	
Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.	
Application information	
Where application information is given, it is advisory and does not form part of the specification.	

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